

## CLAIMS

1. Device for the parallel conduct or study of chemical reactions, characterized in  
5 that the device comprises at least the following components:
- (a) at least two spatially separated reaction spaces;
  - (b) on the reaction space input side, at least one common educt feed for the  
reaction spaces according to (a), or for subsets of them;
  - (d) on the reaction space output side, at least one connection per reaction  
10 space to at least one holding gas feed common to all the reaction spaces,  
or subsets of them;
  - (e) on the reaction space output side, and downstream of the connection to  
the holding gas feed according to (d) in the product flow direction, at  
least one restrictor per reaction space.
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2. Device for the parallel conduct or study of chemical reactions, characterized in  
that the device comprises at least the following components:
- (a) at least two spatially separated reaction spaces;
  - (b) on the reaction space input side, at least one common educt feed for the  
20 reaction spaces according to (a), or for subsets of them;
  - (d) on the reaction space output side, at least one connection per reaction  
space to at least one holding gas feed common to all the reaction spaces;
  - (d') on the reaction space output side, at least one connection per reaction  
space to at least one control fluid feed common to all the reaction spaces;
  - (e) on the reaction space output side, and downstream of the connection to  
25 the holding gas feed according to (d) and the connection to the control  
fluid feed according to (d') in the product flow direction, at least one re-  
strictor per reaction space.

3. Device according to Claim 1 or 2, characterized in that the device also comprises at least one other of the following components:
- (c) on the reaction space input side, at least one restrictor per reaction space;
  - (f) at least one unit for analyzing the products from the individual reaction spaces;
  - (g) at least one common heater for the reaction spaces, and at least one other separate heater for at least one functionally related set of restrictors.
4. Device according to at least one of Claims 1 to 3, characterized in that at least the components (a), (b), (d), (e) and optionally (c) are hermetically connected to one another.
5. Device according to Claim 4, characterized in that the components are hermetically connected to one another even at pressures in excess of 20 bar.
6. Device according to at least one of the preceding claims, characterized in that the components (a), (b), (d), (e) and optionally (c), (d') and (f) are each connected to one another either directly or via channels, tubes or capillaries.
7. Device according to at least one of the preceding claims, characterized in that the common educt feed comprises at least the following components:
- (i) at least one supply unit for the at least one educt;
  - (ii) at least one pressure controller and/or mass flow controller for the at least one educt.
8. Device according to at least one of the preceding claims, characterized in that the common educt feed takes place via a manifold, a bifurcating arrangement of channels, tubes or capillaries with a common node/mixing point, or via an educt feed chamber.

9. Device according to at least one of the preceding claims, characterized in that each restrictor according to (e), and optionally each restrictor according (c), presents a flow resistance in the device resistance at least 50% greater than any other component in the device, apart for all the other restrictors.
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10. Device according to at least one of the preceding claims, characterized in that the restrictors according to (e), and optionally the restrictors according to (c), are selected from the group comprising: metal plates with bores, sintered metal plates, pinholes, frits, porous materials, capillaries, micromachined channels.
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11. Device according to Claim 10, characterized in that capillaries are used as restrictors, and the average internal diameter of the capillaries is in the range of from 5  $\mu\text{m}$  to 500  $\mu\text{m}$ .
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12. Device according to at least one of the preceding claims, characterized in that the volume of each of the reaction spaces is in the range of from 0.1 ml to 50 ml.
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13. Device according to at least one of the preceding claims, characterized in that the reaction spaces are designed as reaction channels, and each of them has an inset for holding solids.
14. Device according to at least one of the preceding claims, characterized in that the common holding gas feed comprises at least the following components:
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- (i) at least one supply unit for the holding gas,
  - (ii) at least one flow meter,
  - (iii) at least one pressure controller.
15. Device according to Claim 14, characterized in that all or subsets of the reaction spaces are connected via a connection, which is hermetic up to at least 20 bar, to a holding gas feed common to all the reaction spaces, or subsets of them.
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16. Device according to at least one of Claims 2 to 15, characterized in that the common control fluid feed comprises at least the following components:
- (i) at least one supply unit for the control fluid,
  - 5 (ii) at least one mass flow controller,
  - (iii) downstream (relative to the flow direction of the control fluid) of the mass flow controller, one restrictor per connection of the control fluid feed to the reaction spaces.
- 10 17. Device according to at least one of Claims 2 to 16, characterized in that the connections intended to lead from the control fluid feed to the reaction spaces are brought together at a node/mixing point with the connections attached to the reaction spaces on the reaction space output side for discharging the products.
- 15 18. Device according to Claim 17, characterized in that the nodes/mixing points for feeding the control fluid are downstream (relative to the flow direction of the control fluid) of the restrictors of the control fluid feed, and also upstream (relative to the flow direction of the product/products) of the restrictors on the
- 20 reaction space output side [restrictors according to (e)].
19. Method for the parallel conduct or study of at least two chemical reactions in at least two spatially separated reaction spaces, characterized in that the method has at least the following steps:
- 25 (A) bringing at least one substance in at least two spatially separated reaction spaces in contact with at least one educt via at least one educt feed common to all the reaction spaces, or subsets of them;
  - (B) simultaneously bringing at least one product flow from of the at least two spatially separated reaction spaces in contact with a holding gas from a
  - 30 holding gas feed common to all the reaction spaces, or subsets of them.

20. Method according to Claim 19, characterized in that it also comprises at least the following further step:
- 5 (C) simultaneously bringing the at least one product flow from of the at least two spatially separated reaction spaces in contact with a control fluid from a control fluid feed common to all the reaction spaces, or subsets of them.
- 10 21. Method according to Claim 19 or 20, characterized in that at least one of the at least two chemical reactions is not a constant volume reaction.
- 15 22. Method according to at least one of Claims 19 to 21, characterized in that the educt flows are at least approximately distributed equally over all the reaction spaces by the restrictors upstream of the at least two spatially separated reaction spaces, or by the restrictors downstream of the reaction spaces, or by both.
- 20 23. Method according to at least one of Claims 19 to 22, characterized in that volume fluctuations which may occur in the reaction spaces are reduced or compensated for by feeding an inert holding gas via at least one common holding gas feed.
- 25 24. Method according to at least one of Claims 19 to 23, characterized in that in start-up operation, that is to say before the at least one chemical reaction has taken place in the reaction spaces, the holding gas from the common holding gas feed is adjusted to a pressure which corresponds approximately to the intended pressure of the reaction spaces while the chemical reactions are taking place, and the educt flow from the common educt feed is subsequently adjusted so that educt flows into the reaction spaces from the common in educt feed.
- 30 25. Method according to at least one of Claims 19 to 24, characterized in that the reaction space is loaded with at least one solid, and in that the exposure of the

solid to the educt is specified as GHSV in the event that the educt is a gas, or in LHSV units in the event that the educt is a liquid, and in that the GHSV is from  $300 \text{ h}^{-1}$  to  $10,000 \text{ h}^{-1}$  or the LHSV is from  $0.2 \text{ h}^{-1}$  to  $10 \text{ h}^{-1}$ .

- 5     26. Method according to at least one of Claims 19 to 25, characterized in that the pressure in the reaction spaces is in the range of from 2 to 200 bar.
27. Method according to at least one of Claims 19 to 26, characterized in that a pressure drop of at least 10 bar is produced in the restrictors downstream of the reaction spaces in the flow direction.
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28. Method according to at least one of Claims 19 to 27, characterized in that a constant non-zero control fluid flow is adjusted in start-up operation, and the flow of educt through the reactor is respectively reduced or increased by increasing or reducing this control fluid flow when the reaction is taking place, specifically without the pressure in the reaction spaces being significantly affected by this.
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29. Method according to at least one of Claims 19 to 28, characterized in that, the method being carried out in a device according to at least one of Claims 1 to 18.
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30. Device for the parallel conduct or study of multiphase chemical reactions, characterized in that the device comprises
- 25     (a) at least two spatially separated reaction spaces;
- (b) on the reaction space input side, at least one common educt feed for the reaction spaces according to (a), or subsets of them;
- (b') on the reaction space input side, at least one common educt liquid feed for the reaction spaces according to (a), or subsets of them;

- (b'') on the reaction space input side and as part of the connections of the common educt liquid feed to the reaction spaces according to (a), at least one restrictor per connection;
- (e') on the reaction space output side and downstream of the connection to an optional control fluid feed, in the flow direction of the at least one product, at least one gas-liquid separation unit per reaction space;
- (e'') associated with each gas-liquid separation unit, a connection for discharging the at least one reaction gas;
- (e''') per connection according to (e'') and via a node/mixing point, a connection to a common holding gas feed;
- (e'''') after the nodes according to (e'''), that is to say downstream in the flow direction of the reaction gas, but before an optional analysis unit, at least one restrictor per connection according to (e'').
31. Device according to Claim 30, characterized in that the connections of the common educt liquid feed to the at least two reaction spaces are spatially and materially separated from the connections of the common educt feed according to (b) to the reaction spaces.
32. Device according to Claim 30 or 31, characterized in that the device also comprises at least one other of the following components:
- (c') on the reaction space input side and associated with the connections of the common educt feed to the at least two reaction spaces, at least one restrictor per reaction space;
- (d') on the reaction space output side, at least one connection per reaction space to at least one control fluid feed common to all the reaction spaces;
- (f) at least one unit for analyzing the reaction gases from the individual reaction spaces;
- (g) at least one common heater for the reaction spaces, and at least one other separate heater for at least one set of restrictors.

33. Device according to at least one of Claims 30 to 32, characterized in that at least one of the reaction spaces according to (a) is designed as a gas-liquid-solid reactor.
- 5 34. Device according to at least one of Claims 30 to 33, characterized in that the gas-liquid separation units are precipitators and/or condensers, and the gas-liquid-solid reactor is a trickle bed reactor.
- 10 35. Method for the parallel conduct or study of at least two chemical reactions in at least two spatially separated reaction spaces, characterized in that the method has at least the following steps:
- (A') bringing at least one substance per reaction space in at least two spatially separated reaction spaces in contact with at least one educt via at least one educt feed common to all the reaction spaces, or subsets of them,
- 15 and with at least one educt liquid via at least one educt liquid feed common to all the reaction spaces, or subsets of them;
- (B') simultaneously bringing the at least one reaction gas flowing out of each gas-liquid separation unit in contact with a holding gas from a holding gas feed common to all the gas-liquid separation units;
- 20 (D) introducing the product flows flowing out of the reactor into at least one gas-liquid separation unit per reaction space.
36. Method according to Claim 35, characterized in that it comprises at least one further step:
- 25 (C') simultaneously bringing the at least one product flow from at least two spatially separated reaction spaces in contact with a control fluid from a control fluid feed common to all the reaction spaces.
- 30 37. Method according to Claim 36, characterized in that the control fluid is a gas and this gas is not only used for controlling the flows through the reaction



spaces, but also contributes to stripping gases and volatile substances which may be dissolved in the liquid phases emerging from the reaction spaces in the gas-liquid separation unit.

- 5     38. Method according to at least one of Claims 35 to 37, the method being carried out in a device according to at least one of Claims 30 to 34.
39. Use of the device according to at least one of Claims 1 to 18 or 30 to 34, or of a method according to at least one of Claims 19 to 29 or 35 to 38, for at least  
10     one standard petrochemical reaction.
40. Use according to Claim 39, characterized in that the at least one reaction is selected from the reaction classes of hydroprocessing, hydrocracking, desulfurization (HDS), denitrogenation (HDN), oligomerizations, polymerization re-  
15     actions, aromatization reactions, hydrogenations, Fischer-Tropsch reactions.
41. Device for the processing or testing of at least one chemical reaction, comprising at least one unit for the controlled discharge of product fluid out of at least one high pressure end fluid separation unit, wherein said fluid separation  
20     unit is in fluid connection, via a discharge valve, with a collecting area that is at a lower pressure than the high pressure fluid separation unit.
42. Device according to claim 41, characterized in that at least two reactions run in parallel and that at least two fluid separation units, either on the high or at the  
25     low pressure end, or both, are connected in parallel.
43. Device according to claim 41 or 42, characterized in that at least one discharge valve is positioned at the bottom side of at least one fluid separation unit on the  
30     high pressure end.
44. Device according to any one of claims 41 to 43, characterized in that the collecting area for the product fluid is a fluid separation unit located at the low pressure end with respect to the high pressure end fluid separation unit.

45. Device according to any one of claims 41 to 44, characterized in that at least one fluid separation unit contains a fluid level sensor.
- 5 46. Device according to any one of claims 41 to 45, characterized in that the device contains means for regulating pressure or fluid flow or both.
47. Device according to any one of claims 41 to 46, characterized in that the discharge valve, the fluid level sensor and the means for regulating pressure or  
10 fluid flow are connected to a computer-based control unit.
48. Device according to any one of claims 41 to 47, characterized in that at least one high pressure end fluid separation unit is suited for accommodating product fluid having a volume ranging from 0.1 ml to 140 ml.
- 15 49. Method for the controlled discharge of product fluid out of a high pressure end separation unit that is part of a device for the processing or testing of at least one chemical reaction, comprising at least the following steps:
- (i) opening of a discharge valve triggered by the signal of a level sensor in  
20 at least one separation unit;
- (ii) discharging of the product fluid from the at least one separation unit, via said discharge valve, into at least one collecting area;
- (iii) closing of said discharge valve, triggered by a signal corresponding to a change in pressure and/or a change in fluid flow.
- 25 50. Method according to claim 49, further comprising at least the following step:
- (iv) directing gaseous product flow through the collecting area.
51. Method according to claim 49 or 50, further comprising the following step:
- 30 (v) directing the product fluid of the collecting area to an analysis system.

52. Method according to one of claims 50 or 51, wherein the gaseous product from the high pressure end separation unit is directed into the low pressure end separation unit by means of a dip pipe or a tube.
- 5 53. Method according to one of claims 50 to 52, wherein the gaseous product coming from the low pressure end separation unit is directed to an analysis system.
54. Method according to any one of claims 49 to 53, wherein at least two separation units are operated in parallel.
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55. Device according to claims 41 to 48 to be used in conjunction with a device according to claims 1 to 18 or 30 -34; or use of the method according to claims 49 to 54 to be used in combination in a method according to claims 19 to 29 or
- 15 35 to 38.